

# Web-Based and Model-Driven Decision Support Systems: Concepts and Issues

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## Abstract

New technologies, especially the World-Wide Web technologies, have created many opportunities for research about Decision Support Systems. This paper reviews key concepts and technical issues. The technology of DSS is evolving rapidly and academic researchers need to catch-up with practitioners who are implementing innovative DSS. The paper briefly mentions a number of Web sites with innovative DSS that highlight current developments. Much remains however to be investigated and studied if DSS are to contribute to a company's success.

## Introduction

Corporate Intranets and the Global Internet are the focus of much activity for developing next generation Decision Support Systems (cf., Power and Kaparthi, 1998). On these networks, organizations are developing innovative Web-Based DSS. Despite recent successes with these technologies, many technical issues associated with Web-Based DSS need to be addressed in research projects. For a number of reasons, investigating issues associated with implementing Model-Driven DSS on the Web is especially important. Model builders must make many assumptions and users and developers may not understand the limitations and potential of Model-Driven DSS delivered by a Web browser.

This paper provides an overview of conceptual and technical issues related to Web-Based DSS and especially Model-Driven Decision Support Systems.

## Key Concepts

When software vendors propose implementing a Web-Based Decision Support System, they are referring to a computerized system that delivers decision support information or decision support tools to a manager or business analyst using a Web browser such as Netscape Navigator or Internet Explorer (Power, 1997; Power, 1998).

Web-Based DSS can help retrieve, analyze and display structured data from large multidimensional or relational databases, provide access to a model or expert system, provide access to multimedia documents and unstructured data, and facilitate communication and decision making in distributed teams. In general, all types

of Decision Support Systems including Data-Driven, Model-Driven, Knowledge-Driven, Document-Driven, and Communications-Driven DSS can be implemented using Web technologies (see Table 1).

The Web technologies have expanded the scope of all DSS and especially Communications-Driven and Group DSS. Data-Driven DSS like Data Warehouses and Executive Information Systems can be delivered using a Web browser. Many new possibilities have been created for Document-Driven and Knowledge-Driven DSS as well. What we also need to realize is that traditional Model-Driven DSS built using optimization, forecasting or other quantitative models can be distributed more widely using the Web and that new opportunities are now available for creating this type of traditional DSS. The Web is also a good platform for delivering decision support to a company's customers, suppliers and other stakeholders.

Table 1. Implementing Decision Support Systems

DSS Types	Technology	
	LAN-Based	Web-Based
Communications-Driven and GDSS	Narrow scope	Global scope
Data-Driven	Thick-client	Thin-Client
Document-Driven	Limited, .doc,.xls	Also HTML, Search engines
Knowledge-Driven	Stand-alone PC	Shared rules
Model-Driven	Single user	Multiple users

Model-Driven Decision Support Systems emphasize access to and manipulation of a statistical, financial, optimization or simulation model. Online analytical processing (OLAP) systems that provide complex analysis of data can be classified as hybrid DSS systems providing both modeling and data retrieval and data summarization functionality. Model-Driven DSS use data and parameters provided by decision makers to aid decision makers in analyzing a situation, but they are not necessarily data intensive, that is very large data bases are not needed for many Model-Driven DSS. The initial

Decision Support Systems discussed in the 1970s by Scott-Morton (1971), Gerrity (1971) and Little (1970) are best classified as Model-Driven Decision Support Systems (see Power, 2000).

A Communications-Driven DSS supports more than one person working on a shared task, examples include integrated tools like Microsoft's NetMeeting™. Communications-Driven DSS support communication, collaboration, and coordination. A Group DSS includes decision models like rating or brainstorming and support for communication, collaboration, and coordination.

Data-driven DSS or Data-oriented DSS emphasize access to and manipulation of a time-series of internal company data and sometimes external data.

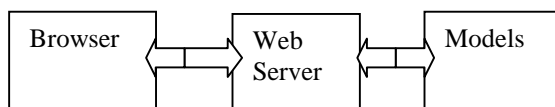
Document-Driven DSS manage, retrieve and manipulate unstructured information in a variety of electronic formats. This type of DSS assists in knowledge categorization, deployment, inquiry, discovery and communication.

Knowledge-Driven DSS have specialized problem-solving expertise stored as facts, rules, and procedures or in similar structures. The "expertise" consists of knowledge about a particular domain, understanding of problems within that domain, and "skill" at solving some specific problems.

### Implementing Web-Based DSS

A Web-Based DSS is hosted on a computer with Web Server software like the Apache WWW server software. The computer server is linked to the user's computer by a network using the TCP/IP protocol. Most Web-Based DSS support a three or four-tier architecture in which a Web browser sends hypertext mark-up language (HTML) requests using the hypertext transfer protocol (HTTP) to a Web server. The Web server processes these requests using a Common Gateway Interface (CGI) script. The script handles model processing, Structured Query Language (SQL) generation, post-SQL processing, and HTML formatting. This application server then sends requests to a modeling program or a database server (see Figure 1). Many technology improvements are occurring that are speeding up model processing and query processing. Tools like Java™ and JavaScript are improving the display of results and the interactive analysis of data and models.

Figure 1. Web-Based DSS Architecture

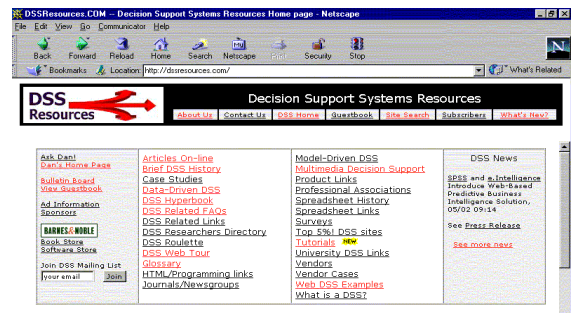


Building Decision Support Systems with these new tools is a complex development task. Web-based DSS are available seven days a week and 24 hours a day and users will have different needs. Web architectures need to handle a large number of concurrent requests, while maintaining consistent response times as the number of users and volume of data changes.

### Examples of Web-based DSS

A number of Web sites have information on Decision Support Systems. For example, the Data Warehousing Information Center at URL <http://www.dwinfocenter.org/> has an extensive list of tools and tool vendors. DSSResources.COM at URL <http://dssresources.com/> has articles on DSS, a glossary and links to companies that market DSS products.

Figure 2. DSSResources.COM



Many DSS vendors have Web-based DSS products and a number of vendors have examples of their products at their Web sites. For example, InterNetivity (<http://www.internetivity.com/>) has eleven data cubes that can be analyzed with their Java Web-based data reporting and analysis product dbProbe. Also, many retail and portal Web sites have Web-Based DSS.

Microsoft Carpoint at URL <http://carpoint.msn.com> demonstrates a Web-Based DSS. Users can search a used car database and use the Kelley Blue Book to establish a standard price for a particular make and model. The Compare it! feature permits pair-wise comparison of new car alternatives across multiple pre-specified attributes. The Payment Calculator is a Java™ applet.

drkoop.com at URL <http://drkoop.com> has a Drug Checker application to help make sure the medications a person takes do not interact with each other or with food to cause an adverse reaction. At drkoop.com users can also find more than 20 "Health Calculators" on topics like stress, nutrition and fitness.

Netscape's Decision Guides are examples of Model-Driven Web-Based DSS. More than 25 Decision Guides are available at <http://home.netscape.com/decisionguides>. Topics for guides include choosing pets, bikes and business schools.

An excellent example of a Model-Driven DSS on the Web that uses a financial model and a large database is the Intrinsic Value Calculator at <http://www.quicken.com>. The financial valuation model calculates a hypothetical value called the intrinsic value per share based on a company's earnings. The earnings data and other needed values are taken from an extensive company financial database. DSS users are presented with an initial set of parameters and a preliminary calculation of intrinsic value, users can then conduct "what if?" analyses. For example, users can choose a specific historical growth rate or choose a growth rate that seems appropriate.

## Issues

Research about Decision Support Systems has stagnated in recent years. Some academics perceived that we understood all of the issues. Others moved on to topics that seemed more interesting or that were more tractable to empirical research. The World-Wide Web technologies have created new opportunities for DSS research and for developing innovative decision support systems. The concepts and technical issues are evolving and academic researchers need to catch-up with practitioners. On the Web one finds many innovative DSS, but some are more effective than others and some better support users than do others. Many topics need to be investigated and studied if DSS are to realize the potential envisioned in the early 1970s (cf., Gerrity, 1971).

More research is needed that focuses on building and evaluating Web-Based Decision Support Systems. It is especially important to investigate Model-Driven DSS implemented using Web technologies and a "thin-client" Web browser like Netscape Navigator.

Researchers need to investigate design methodologies for Model-Driven DSS implemented using Web technologies. Academic researchers need to begin developing more DSS in programming languages like Java™, JavaScript, and Perl. We need to compare and contrast these programming environments for various types of Decision Support applications. For example, what works best for developing Data-Driven versus Document-Driven DSS?

Theorists need to discuss the level of detail and precision to include in Web-Based decision models. Also, researchers need to examine model management in Web server and distributed computing environments.

Much more research needs to be done evaluating Web-Based DSS designs. Most current systems are not systematically evaluated once they are implemented. Researchers need to investigate linking models and database technologies in a Web environment. The role and effects of user involvement in Web-Based DSS design and development need to be studied. In general, we need to examine the comparative effectiveness of different interactive structures for DSS. Also, case studies

are needed of Web-Based Model-Driven DSS applications and Web-Based DSS for customers and suppliers.

Today, a number of disciplines provide the substantive foundations for DSS development and research. Database researchers have contributed tools and research on managing data. Management Science has developed mathematical models for use in Model-Driven DSS and provided evidence on the advantages of modeling in problem solving. Because so many disciplines impact DSS development and research, theory development has been narrow and specialized rather than comprehensive and inclusive. A major challenge is to broaden, define and test theories related to improving decision-making using computing technology. Managers, customers and other stakeholders will use more Web-Based DSS and yet we have little theory to guide us in constructing the various types of Web-Based DSS.

## Conclusions

Web-Based DSS have reduced technological barriers and made it easier and less costly to make decision-relevant information and Model-Driven DSS available to managers, staff users, customers and suppliers. The Web has increased access to DSS and it should increase the use of well-designed decision support systems. Using a Web infrastructure for building DSS can improve the rapid dissemination of "best practices" analysis and decision-making frameworks and it should promote more consistent decision-making on repetitive tasks.

Managers and MIS professionals should note that Web-Based DSS could provide companies with a competitive advantage. These proprietary systems will primarily impact internal decision processes and make them faster and more predictable. Web-Based DSS can also improve customer service where a decision is required.

The Web is where the DSS action is today. Most major DSS software vendors have made a major commitment to the Web for providing product information and for creating new DSS products. Visiting DSS Web sites is a great learning experience for students, teachers and practitioners. Reading Web documents and using Web-Based DSS provides invaluable information about current DSS topics.

Overall, Web-Based Decision Support Systems show great promise for contributing to the success of organizations, but more research can help improve the design and implementation of these systems.

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